than Britain in pushing on railway construction and promoting the expansion of their commerce. Dr. H. O. Forbes read a report on the work of his expedition to Sokotra. Dr. J. P. Thompson, the energetic Queensland geographer, contributed a comprehensive account of the geography of the State.

Exploration is now no longer confined to foreign lands, and some of the younger botanists have shown us what can be done when the plant world at home is regarded geographically. From the point of view of pure science they are making an important contribution to the study of the relationship between organisms and environment, and compiling part of the data necessary for the study of macro-organisms—the complex associations of rock, air, water, and organic life considered as a whole, which are the subject-matter of the geographer. From the point of view of applied science they are carrying out an equally valuable work, for a knowledge of the characteristics and distribution of the different plant associations is the best clue to the possibilities and limits of their profitable exploitation for the production of economically important plants and animals. Such botanical surveys might well be subsidised by the Board of Agriculture. The example of the Canadian Geological Survey might be followed, and the work be entrusted to teachers of botany who would carry it out in their vacations.

Dr. Otto Darbishire, of Owens College, discussed the general problem of the relations of botany and geography, and insisted on the necessity for modern travellers having a knowledge of ecology. Dr. W. G. Smith, of the Yorkshire College, who has carried on the work of his deceased brother, who planned a botanical survey of Great Britain, also urged the importance of the observation and mapping of vegetation features in geographical exploration, and illustrated his thesis by reference to the maps already made for Britain. The maps made of the plant associations of the Eden, Tees, Tyne, and Wear basins by Mr. F. J. Lewis, of University College, Liverpool, were shown and described, and Mr. Moss discussed the age and origin of the peat moors of the southern Pennines.

One of the applications of botanical geography to practical affairs was well illustrated in a valuable paper by the chief engineer of the Liverpool Waterworks, Mr. Parry, who has been the pioneer in the afforestation of the catchment areas of water reservoirs, which has been proved to increase the purity of the water supplied to the citizens and to protect their pockets. Mr. E. D. Morel also discussed a problem in applied geography. He pointed out the value of West Africa for the production of raw cotton, and the results that had been obtained by appealing to the commercial instincts of the natives instead of having recourse to coercion. The importance of a study of native land and administrative systems was emphasised.

Mr. E. A. Reeves read a timely paper on the nature of geographical surveying suited to present requirements, when route charts must be replaced by maps based on surveys planned on scientific lines, while not so elaborate or accurate as large trigonometrical surveys. Mr. E. Heawood contributed the one paper on the history of geography. He discussed the newly discovered maps of Henricus Glareanus, who first described a convenient method for constructing the gores of a globe. One of his maps is the earliest known which shows a hemisphere on an equidistant polar projection.

The geography and education sections held a joint sitting to discuss geographical education. Mr. H. J. Mackinder opened with an eloquent exposition of the regional method of teaching geography and of the possibility of weaving into the regional treatment so much as is needed of other sciences by taking these one at a time in the successive stages of the strictly geographical argument. He submitted that geography could be placed in its rightful position only by the simultaneous application of a four-fold policy:—(1) The encouragement of university schools of geography where geographers should be made, of whom many would become secondary teachers; (2) the appointment of trained geographers as teachers in our secondary schools, either for geography alone or for geography and general help in other subjects; (3) the general acceptance of a progression of method in the subject, not expressed in detailed syllabuses issued by the State or other dominant authority which would tend to stereotype teaching, but in a tradition similar to that which at different times has governed the teaching of language and mathematics; (4) the setting of examinations by expert geographical teachers.

Mr. Hugh Richardson gave a valuable account of how he taught his pupils from thirteen to seventeen years of age the use of maps and books, and insisted on the value of laboratory work on which their books gave little help. Mr. Hewlett spoke of aims and difficulties in the teaching of geography, and Mr. Cloudesley Brereton of geography in secondary education.

In the discussion which followed, the main objections urged against Mr. Mackinder's ideas were that sufficient time was not allowed for carrying them out, and that it was impossible to adopt his suggestion that pupils should be grouped in special sets for the geography lessons. The need for teachers who have had a training in geography, and the value of geography as a coordinating subject in the curriculum, seemed to be recognised by all.

A. J. H.

ENGINEERING AT THE BRITISH ASSOCIATION.

The section had a lengthy programme to work through at Southport, but it must be confessed that there were but few papers of outstanding importance.

On Thursday, September 10, after Mr. Hawksley's presidential address, which naturally dealt mainly with the problem of the supply of water to cities and villages, a paper was read by Mr. C. A. Brereton on the new King Edward VII. bridge over the River Thames, at Kew. The author showed some interesting lantern slides to explain more clearly the method of construction adopted in previous bridges which crossed the river at this site, and also in the case of the new structure. It was not until 1892 that, induced by the increase in the traffic and the inconvenience caused by the narrowness of the old bridge and the steepness of its gradients, the County Councils of Surrey and Middlesex decided to take steps to replace the bridge by a new one; the necessary Act of Parliament was eventually obtained in 1898, the contract was then let to Mr. Gibb, and the work was begun at once.

The bridge consists of three elliptical arches, the centre one being of rather longer span than the two side arches; it has a span of 133 feet, and a headway of 20 feet above Trinity high-water mark, while the two side spans are only 116 feet 6 inches in span, with a headway of 17 feet. The piers from which these three arches spring are carried down into the solid London Clay at a depth of 18 feet below the bed of the river. The width of the carriage way is 36 feet, and there are 9 feet 6 inch footways on either side; the maximum gradient is only 1 in 40. The whole of the arches, and the exterior of the piers, is constructed of solid granite, chiefly Cornwall and Aberdeen, many of the big stones weighing as much as 8 tons each. To provide for the traffic during the construction of the new bridge, a temporary timber bridge was put up alongside the old one; this was completed in the remarkably short time of six months. The cofferdams for the piers of the new bridge were started in December, 1899, and but little difficulty was met with in their construction. All three arches were constructed simultaneously, and therefore it was necessary for all the stones for the arches to be brought on to the ground before the turning of the arches was commenced; every stone was numbered and placed in the receiving yard ready to take its place in the work. The masonry of the arches was commenced in May, 1902, and completed in December of that year—an extremely expeditious piece of work. The total length of the bridge proper is 502 feet, the approaches on the Middlesex and Surrey sides bringing the overall length to 1182 feet. The bridge was opened by His Majesty the King on May 20 last, having taken about three and a half years to construct; one year was occupied in the construction of the temporary bridge and the removal of the old bridge.

The only other paper dealt with on the Thursday was an interesting contribution by Mr. J. Harrison—illustrations of graphical analysis. The author gave an account of a simple graphical method of obtaining equations for the displacement of the valve, and for the sliding of the block in the link in an ordinary Stephenson's link gear. In fact, it was a graphical method of analysing a Fourier series, the author's methods being exceedingly neat and handy, but requiring very exact and careful draughtsmanship.

The first paper taken on Friday, September 11, was specially written in order to prepare members for the visit of the section on Saturday to the new Manchester Municipal Technical Institute. Principal J. H. Reynolds gave, with the aid of a number of lantern slides, an interesting account of the construction and equipment of this great technical institute. The author's paper was practically a defence of the methods which have been adopted in connection with the equipment of the engineering and other departments of this Institute; the authorities have been attacked for fitting up their laboratories with unnecessarily complicated apparatus, probably beyond the capacity of the class of students they are likely to have, and it must be admitted that there is some justification for this criticism. Members of the section were better able to form their own opinion on this controversy after the visit on Saturday. As regards the strength of materials laboratory, the machines are those ordinarily employed, with the addition of a very powerful appliance for compression purposes, but as it happens to be extremely simple in construction, being nothing more or less than a modified cotton press, it can be used as easily by students (though its capacity runs into hundreds of tons) as if it were a machine of only a few tons capacity. In the steam engine laboratory, however, there is no doubt that the experimental engine, a fine piece of design due to Prof. Nicolson, is on too big a scale for teaching purposes; it may be an admirable instrument for research in the hands of Prof. Nicolson, and therefore the authorities of the college may be justified in the expenditure which must have been incurred both in the original purchase of this engine and in its working expenses, but for the instruction of the students likely to frequent such a technical institute, it would have been far better to have provided half a dozen engines, each, say, of 10 to 15 horse-power, and each of a different type. The changes in essential points in the design of prime movers of all kinds, and in fact of most machinery, come so rapidly, that if a college is to keep its equipment up to date, it should not be of too expensive a character, as it will be necessary pretty frequently to scrap apparatus, and replace it by newer plant more in accordance with the practice and design of the day. Another criticism which might be offered upon the equipment of the whole college is that too much apparatus has been put in at once; it would have been undoubtedly wiser to have arranged for the equipment to be gradually and steadily increased year by year as the number of students increased, and the demand for such increased apparatus arose.

At the conclusion of this paper, and after a brief discussion, the report of the committee on the resistance of road vehicles to traction was taken, and the committee was reappointed for another year. The work of this committee is of such great importance that it will be desirable to direct attention to this report and the work carried out by the committee a little later on in a special article.

Mr. T. Clarkson's paper on improvements in locomobile design was then read. The author is a strong supporter of steam-driven cars; he claimed that there was greater trustworthiness in the case of steam, more certainty in action, more reserve power, that it would to a great extent render unnecessary expensive change speed gears, and that by the use of liquid fuel, burnt in scientifically designed furnaces, there was no smoke and no trouble from the smell produced during the process of combustion. The paper was full of descriptions of exceedingly clever details, such as an ingenious method of automatically controlling the feed when going down or up hill, the pumping of oil under pressure to lubricate every bearing and every moving part, the use of metallic packing, necessary on account of superheated steam being used in the cylinders, and other ingenious devices. If the steam car is ever to be a formidable rival of the oil-driven car, it will certainly be due to the labours of such indefatigable scientific workers as Mr. Clarkson.

The remainder of the day was devoted to a discussion, opened by Lieut.-Colonel Crompton, on the problem of modern street traffic. Unfortunately the discussion came on so late that many had gone away for the day who might otherwise have taken part in it, and no very practical suggestions were made by any of the speakers except that further attention should be paid to the regulation of slow, heavy traffic. It is, however, after all a moot question whether there is so much street obstruction or so much difficulty with the control of modern street traffic as the daily Press would make us believe. Apart from a few of the main thoroughfares in London itself, there is very little delay in our cities caused by congestion of traffic, except in exceptional circumstances and on exceptional days. Colonel Crompton alleged that electric trams were as slow as the old horse omnibuses; if so, his experience of such trams must be very unfortunate; certainly this is not the experience of most people, and in towns like Glasgow, Manchester, and Liverpool, the introduction of electric traction has certainly much increased the speed at which one can pass from one part of the town to another, and in these cities the problem of street traffic is not complicated as it is in a few of the leading thoroughfares in London by the crawling cab nuisance. Probably without inconvenience to the general public many of the cabs in London might be withdrawn, and certainly by a judicious arrangement of underground tube railways, and by the extension of the electric tramway service, the greater part of the cumbersome, slow-moving, obstructive omnibuses might be driven from the streets, and it is in this direction, rather than in expensive widenings and overhead bridges, that the problem of congestion in the central streets of London will have to be met.

Monday, September 14, was devoted almost entirely to electrical papers. The first of these was one by Mr. W. B. Woodhouse on protective devices for high tension electrical systems. The author, who has had considerable experience in work of this nature, briefly described the necessary protective appliances, such as circuit breakers and the devices for preventing or relieving excessive rises of pressure, which are required in high tension electrical power systems. He described several fuses and switches and overload relays which had been found effective in actual practical operation; as regards switches, he was of opinion that the oil-break switch did break circuit at the moment of zero current, and that for this reason it was the one which should be generally adopted. This paper led to an interesting discussion, in which Mr. G. Kapp and Prof. Ayrton were the chief speakers.

Then followed two papers on aluminium as an electrical conductor, one by Mr. J. B. C. Kershaw and the other by Prof. Wilson. Both authors have been experimenting on the effects produced by exposure of aluminium wires and rods to atmospheric influence. Mr. Kershaw's experiments have been conducted on the Lancashire coast, just south of Southport, and Prof. Wilson's in London, on the roof of King's College. Both experimenters found that the aluminium had suffered considerably; Mr. Kershaw found serious corrosion due to the sea air, especially on the under side of the wires, where drops of water had hung for a long time. Prof. Wilson's experiments were a continuation of an earlier series of tests which were described at a previous meeting, and dealt with the effect of atmospheric corrosion on the conductivity of the metal; the later experiments confirm the results obtained in the earlier ones, namely, that an alloy of aluminium with copper alone was inadvisable for electrical purposes when exposed to the atmosphere, as its conductivity diminished steadily, though more slowly after a time.

Of the other papers taken, the most important was that by Mr. B. Hopkinson on the parallel working of alternators; the paper—a highly technical one—it is impossible to summarise. The author dealt with the practical problem of keeping the oscillations, with their accompanying fluctuations in the flow of energy to or from the main or 'bus bars, within moderate limits, and he treated the matter both from the mathematical point of view and in its practical applications.

On Tuesday, September 15, a lengthy programme was dealt with, and we can only refer to a few of the papers. Mr. W. F. Goodrich, in a paper on twenty-five years' progress in final and sanitary refuse disposal, gave some valuable figures as to the progress which has been made in this branch of sanitary engineering. No less than 180 towns are now using destructors; in 63 of these the steam generated is used in electricity works, and in 40 in connection with the pumping plants of the town sewage works, while in 3 cases the power available is utilised by waterworks pumping engines. As a result of numerous tests it might be roughly estimated that every ton of refuse burnt generated about one ton of high pressure steam, and that with the modern high temperature destructor cells the smell and dust nuisances were practically banished.

Liquid fuel was the subject of Mr. A. M. Bell's communication; much information was given as to the various sources of supply and also as to the best types of oil-burning apparatus, and the author quoted some striking figures obtained in recent tests. In a test at Messrs. John Brown and Co.'s works, 16.09 lb. of water were evaporated per pound of Texan oil burnt, the boiler having an efficiency of 84 per cent.; of course a certain proportion, the author says never more than 3 per cent., of the steam is needed for spraying the oil; with a Stirling boiler, which had an evaporation at standard conditions of 10·55 lb. of water per pound of Welsh coal burnt, the evaporation had been increased to 15·42 lb. per pound of Texan oil, when the furnace was suitably modified for oil consumption. It was pointed out in the discussion that still more economical results could be obtained when this oil was used in internal combustion engines.

Dr. H. R. Mill gave the section some interesting data as to the rate of fall of rain at Seathwaite, and pointed out that in these west coast regions of heavy annual fall the maximum rate of fall was nothing like so great as may occur during heavy summer thunderstorms in drier parts of the country, where it may equal at times 3 inches in the hour.

The last paper of the day was one by Mr. R. Pearson on natural gas in Sussex, and it will astonish most persons to learn what a large amount of gas is now obtained in this district. At Heathfield some eighty houses are using it for lighting and heating purposes, and gas engines utilising it develop a horse-power on a consumption of about fifteen cubic feet of the natural gas per hour. With the development of the Kentish coal-fields and the Sussex gas and oil-fields, both by no means improbable in the early future, there is no doubt that the south-eastern corner of England would undergo an industrial revolution; much as one might regret to see its lovely rural and pastoral character disappear, everyone would welcome the advent of manufacturing industry into this somewhat sleepy corner of the kingdom.

The section had, in consequence of its lengthy programme, to sit on the morning of Wednesday, September 16, when a number of very interesting communications were dealt with. Members of the staff of Messrs. Willans and Robinson contributed two papers—Mr. C. H. Wingfield described experiments on the permanent set in cast-iron as bearing on the design of piston-ring springs, and Mr. Izod a piece of apparatus for testing the brittleness of steel. Both papers are the outcome of the constant experimental research going on in the modern up-to-date engineering workshop, and are a sufficient answer to the reproaches of those who, knowing little or nothing of what they write about, are constantly declaring that trade is leaving the country owing to the apathy and stupid conservatism of our manufacturers. Both communications should be carefully studied by those engaged in the study of the strength of materials.

Mr. W. Odell described some experiments he had carried out to determine the power wasted by the windage of fly-wheel and dynamo armatures, and he stated that a 9-foot disc running at 500 revolutions a minute would absorb about 10 H.P. Mr. W. Cramp read a paper on single phase repulsion motors, a matter of great practical importance in electric tramway work; he claimed that the problem had been solved, and that a single phase alternating current motor had been designed quite equal to a direct current motor.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE anthropological section met in the Town Hall, Southport, under the presidency of Prof. Johnson Symington, F.R.S., of Queen's College, Belfast, and, as usual, attracted large audiences. The programme was a full one, and the principal communications were in the department of Egyptian, Mediterranean, and British archæology, a fact which is partly attributable to the widespread feeling—very clearly expressed by the President of the Association in the course of one of the discussions—that the human sciences, in the older and more academic sense, fall properly within the scope of the Association's work, and merit scientific recognition.

Most important, perhaps, among these new accessions to the section's programme was the group of papers on work in Roman Britain, an area where a subject, which elsewhere can be treated in the full light of written history, has to be explored almost wholly by the methods of prehistoric archæology; and the appointment, with a small grant, of a committee of the Association "to cooperate with local effort on Roman sites in Britain" cannot fail to strengthen both the subject and the section at large.

The president's address, which dealt with the relations between brain and skull, and with the problems which result, has been already printed in full (October 1, p. 539), and gave a broad and philosophic tone to the opening discussion; but the subsequent papers on points of anthropography dealt almost wholly with detailed work of a somewhat specialist kind. Dr. Wm. Wright's account of the skulls from round barrows in east Yorkshire, now in the Mortimer Museum at Driffield, led to the conclusion that the old dictum enunciated by Thurnam—"round barrow, round skull"—is not even approximately accurate for this area, for the cephalic index ranges from 69 to 92, and almost all the European varieties of cranial shape are represented. A marked resemblance, however, was frequently noted between the skulls from any one barrow.

Mr. W. L. H. Duckworth's investigation of the physical anthropology of Crete and Greece, though still incomplete, has brought together a large mass of new material of many periods for the reconsideration of the ethnology of the Ægean area. The bones from the pre-Mycenæan ossuaries of Palæokastro, in eastern Crete, show a purely Mediterranean type, which is shared by those from Mycenæan interments on the Greek mainland; whereas even in Crete, and universally on the mainland, the modern population betrays by its brachycephaly a large admixture of Albanian, Venetic, or Slav intruders. Eastern Crete, however, is more brachycephalic now than the central districts, and this Mr. Duckworth is inclined to attribute to intrusions from Asia Minor. A further grant made by the Association will, it is hoped, enable Mr. Duckworth to continue this very promising inquiry.

Dr. E. J. Evatt's observations on the pads and papillary ridges on the palm of the hand showed that the fœtal disposition of these pads resembles that in the mouse and some other lower animals, which is probably morphologically equivalent. In the adult the pads are to be regarded as vestigial. The papillary ridges are produced by the invasion of the corium by the underlying layer; the interlocking of the two probably serves to connect them more strongly; and the patterns are due to the stresses of prehension acting on ridges which originally lay transversely.

Mr. N. Annandale, in describing a collection of skulls from the Malay Peninsula, noted the great development of the cerebellar part of the occiput, and a widespread abnormality of growth of the third molar.

The committees on a pigmentation survey of the school children of Scotland, and on anthropometric investigations among the native troops of the Egyptian Army, presented interim reports of a formal character. In the latter case the 17,000 measurements already taken cannot apparently be worked up for publication without expert clerical assistance, and it is much to be hoped either that this may be provided without undue delay, or that the committee may see its way to hand over its data to one or other of the biometrical centres which have such assistance at their disposal.

The committee appointed to organise anthropometric research presented a short but very useful report. A single year's work has sufficed to collect and collate the experience of practically all the centres at which anthropometric work is being carried on, as to objects of research, methods, instruments, schedules, and the like, and it is next proposed to inquire under what conditions of maintenance and administration a collection of anthropometric statistics could be established as the nucleus of more systematic investigations. The preface to the report, by Prof. Cleland,